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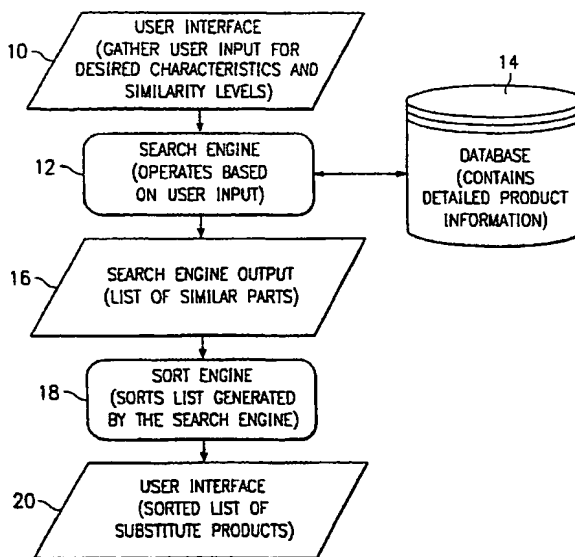
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(54) Title: PRODUCT SUBSTITUTION SEARCH METHOD

(57) Abstract: A system and method for responding to user requests for a product provides a selection of alternate products that are similar to the requested product. Available products each have a plurality of attributes, which are compared to corresponding attributes of the requested product. Available products having attributes which are similar to those of the requested product are ranked in order of a similarity measure, and presented to the user.

Product Substitution Search Method

Technical Field

This invention relates in general to the field of supply chain, enterprise and site
planning and, more particularly, to a system and process for providing product alternates
to partners in a multi-enterprise collaboration.

Description of the Prior Art

Supply chain, enterprise and site planning applications and environments are
widely used by manufacturing industries for decision support and to help manage complex
manufacturing operations. In contrast with conventional planning software applications
that provide a monolithic application architecture, products are becoming available to
support multi-domain, distributed and heterogeneous planning environments that
characterize present day supply chains. One such product is the RHYTHM
COLLABORATION suite of software products available from i2 Technologies, Inc.

An inherent characteristic of such products, and in particular the multi-domain
heterogeneous architecture of the RHYTHM COLLABORATION suite, is that they support
products spanning multiple domains. The products supplied by the seller domain in the
collaboration are consumed by the buyer domain. It is not uncommon that the product
supply is constrained and does not meet the buyer demand. This, in general, leads to lost
sales and customer dissatisfaction for the seller domain and can be further detrimental to
the multi-enterprise supply chain as the buyer domain may not be able to satisfy its own
customers in a timely fashion.

A solution to the problem is to provide the buyer domain with a list of viable
alternate products that can be consumed instead of the original product. This will also
extend the domain of the decision support across multiple enterprises in the supply chain.
It is desirable for decision support software to cover even larger domains in the decision
making process because typically, the larger the domain of the decision support, the more

optimal the decision will be. It is the purpose of the present invention to develop a system and process for providing such product alternates to partners in a multi-enterprise collaborative supply chain.

5   Summary of the Invention

In accordance with the present invention, a system and process for providing product alternates to partners in a multi-enterprise collaborative environment are disclosed that result in increased customer satisfaction, improved demand fulfillment and optimal decision making across multiple enterprises.

10   A computer implemented module within the RHYTHM COLLABORATION suite of products is provided for identifying the best products among the alternates available. The process involves a two-step approach. In the first step, a graphical user interface is used to gather product requirements from the user. This includes specification of the level of similarity between the original product and the alternate products required by the user.

15   Based on the user's input of the product requirements and the desired similarity level, the process employs an algorithm to retrieve alternate products that satisfy the user requirements when compared to the original product. The process involves ranking the alternate products in order of their similarity to the original product. For each of the product characteristics identified by the user in the first search step, the algorithm is used

20   to conduct a detailed similarity analysis which compares the more granular attributes because of which a product possesses the particular characteristic. The result of executing the sort algorithm is the generation of a global index value for each alternate product with respect to the original product. The alternate products are then ranked based on the global index. Finally, a graphical user interface presents the list of alternate

25   products to the user.

In practice, there generally exist numerous feasible alternates to a product and in the absence of an expert system, such as that detailed in the present invention, the user must rely on subjective judgment and experience for trimming the set of feasible alternates to a manageable number. There is a high probability that the optimum alternates will be

5   eliminated in such a subjective process. The system and process in the present invention provide a systematic procedure that will objectively select the best feasible alternates for a product. Another technical advantage of the present invention is that it eliminates the need for the user to know the details of the methodology and performs the search and sort operations based on user specifications through a menu operated graphical user

10   interface.

Additional technical advantages should be readily apparent to one skilled in the art from the following figures, descriptions, and claims.

Brief Description of the Drawings

15   A more complete understanding of the present invention and advantages thereof may be acquired by referring to the following description taken in conjunction with the accompanying drawings, in which like reference numbers indicate like features, and wherein:

FIGURE 1 is a diagram showing an overview of the process used to identify

20   alternate products; and

FIGURE 2 is a diagram that demonstrates calculation of the Attribute Similarity Index.

Description of the Preferred Embodiment

25   In important objective of the present invention is to identify alternate products with adequate supply, which are similar to a candidate product with inadequate supply. A two-step procedure is adopted in the system in order to make it efficient and practical. The

first step rapidly identifies a set of potentially useful alternate products based on product attributes that are desired in the candidate product. The second step evaluates only those alternate products that have been identified in the first step and ranks them based on an analysis of detailed product attributes. Thus the user can review only the few most

5   relevant alternates and satisfy demand for the candidate by increasing the forecasted quantity for one or more of the alternates.

Referring to Figure 1, a user enters requests at some type of user interface 10 as known in the art. The details of the interface 10 are not important to the present invention, and many different known interfaces are suitable for use. A search engine 12 operates to

10   identify similar products, in turn utilizing a database 14 of detailed product information. Operation of the search engine 12 is described in detail below. Search engine 12 generates an output 16 that contains a list of similar parts according to the criteria set forth below. This is not yet presented to the user.

A sort engine 18 accepts as input the output 16 from search engine 12, and sorts

15   the list of similar parts in an order that is most likely acceptable to the user. Details of this process are also described below. Once the preferred order is determined, the sorted list is presented to the user through user interface 20. In many cases, interfaces 10 and 20 will actually be one interface, even though they are separated in Figure 1 for conceptual clarity.

20   The user is presented with a broad range of product characteristics. These characteristics are specific to the manufacturing environment being dealt with. The methodology is demonstrated here by applying it to the computer industry. Broad product characteristics for computers may include processing speed, multi-media support, data storage etc. Through a graphical interface, the user inputs the search intent by specifying

25   the desired characteristics that the search is to be based upon, and the level of similarity for each product characteristic.

Each product characteristic is broken down into elementary components known as attributes. For example, the processing speed can be broken down into the internal clock speed for the CPU, the bus speed, the type and size of RAM. Consider products P_i and P_j. X denotes the set of all attributes for a product e.g. a computer may have the following set

5 of attributes: X = {Processor Speed, Memory Size, Hard File Size, Monitor, CDROM, Operating System}. Two types of attributes can be identified:

a. Continuous valued attributes: The values of this class of attributes bear a decisive resemblance with each other, and the magnitude of the attribute similarity index signifies the degree of resemblance. Examples may include processor speed, RAM

10 size, and hard disk size.

b. Binary valued attributes: The values of this class of attributes are unique and no consistent similarity can be identified among them. Examples may include distinct types of operating systems.

X_m is an element of the set X. $V(X_mP_j)$ is the value of attribute m for product j. In trying

15 to assess whether a product can act as a substitute for another product, the value of each attribute of the candidate substitute is compared with the value of the corresponding attribute for the original product.

The measure used to quantify the similarity of a substitute to the original product in terms of a specific attribute is called the Attribute Similarity Index. Assume that a user is

20 trying to determine if product P_j is a substitute for P_i. In addition, the products are being compared with respect to attribute X_m. The Attribute Similarity Index is denoted as $SI_{ij}(X_m)$. The first index (i) stands for the original product P_i and the second one (j) for the substitute product P_j. The fact that this similarity index is for a specific attribute is denoted by X_m in brackets.

25 The measure used to quantify the similarity of a substitute to the original product taking all attributes into consideration is called the Product Similarity Index. Assume that a user

is trying to determine if P_j is a substitute for P_i. The Product Similarity Index is denoted as SI_{ij}. The first index (i) stands for the original product P_i and the second one (j) for the substitute product P_j. The Product Similarity Index is a weighted sum of Attribute Similarity Indices. Each attribute is assigned a weight. The weights are input obtained from the user through a graphical interface.

Algorithm

1. For each continuous valued attribute in the set X, the maximum and minimum values over all products are determined.

2. Consider a single product, P_i. Calculate Product Similarity Indices, S_{ij}, for all other products, $P_{j, j \neq i}$. Steps involved in doing so are given below.

   a.   Consider a product P_j other than P_i.

   b.   The Attribute Similarity Index $SI_{ij}(X_m)$ is calculated for each attribute in the set X.

   c.   The Product Similarity Index SI_{ij} is calculated.

   d. SI_{ij} is compared with a user-defined threshold value for Product Similarity Index $SI_{i, min}$. $SI_{i, min}$ holds for any product relative to original product P_i.

   e.   Include P_j as a substitute only if the Product Similarity Index exceeds $SI_{i, min}$.

3. The list generated in step 2 is arranged in descending order with respect to Product Similarity Index. In case of a tie with respect to Product Similarity Index, the products will be ranked with respect to the Attribute Similarity Index for the attribute with the highest weight. If even this does not eliminate the tie, the attribute with the second highest weight will be used and so on. The final ordered list of substitutes for product P_i will be denoted as $P_{i, Subs}$.

4. Generate the list for all products.

Similarity Index Calculation

Attribute Similarity Index for Attributes with Numerical Values

Consider the following scenario. The user requests substitutes for product P_O.

5   Assume product P_O has an attribute X_A with value $V(X_A P_O) = A_O$. The maximum and minimum attribute values for attribute X_A have already been generated and are equal to $V_{max}(X_A) = A_{max}$ and $V_{min}(X_A) = A_{min}$ respectively.

Product P_Q and Product P_R are being considered as substitutes for Product P_O. The value of attribute X_A for Product P_O is $V(X_A P_Q) = A_Q$ and A_R for Product P_R.

10   The system will compare the attribute value for the substitute, A_Q with that for the original product, A_O. If A_O is less than A_O, the Attribute Similarity Index for Product P_Q and attribute X_A, $SI_{OQ}(X_A)$ is calculated as follows:

$$SI_{OQ}(X_A) = \frac{x^2 - A^2_{min}}{A^2_o - A^2_{min}}$$

15

If A_Q is greater than A_O, the Attribute Similarity Index for Product P_Q and attribute X_A, $SI_{OQ}(X_A)$ is calculated as follows:

$$SI_{OQ}(X_A) = \frac{x^2 - A^2_{max}}{A^2_o - A^2_{max}}$$

20

If A_Q equals A_O, the Attribute Similarity Index for Product P_Q and attribute X_A, $SI_{OQ}(X_A)$ equals 1.

As an example, consider FIGURE 2, which is a graph of the Attribute Similarity Index for the "Processor" attribute. Here A_O is 233 MHz for which the Product Attribute Similarity Index is 1. A_{max} is 400 MHz and A_{min} is 133 MHz. The following equations hold:

$$SI_{OQ}(X_{Processor}) = \frac{x^2 - 133^2}{233^2 - 133^2}$$

for $133 \leq x < 233$

$$SI_{OQ}(X_{Processor}) = 1$$

for $x = 233$

$$SI_{OQ}(X_{Processor}) = \frac{x^2 - 400^2}{233^2 - 400^2}$$

for $233 < x \leq 400$

5

Attribute Similarity Index for Binary Valued Attributes

If the attribute value for a substitute is not the same as that for the original product, the Attribute Similarity Index for the substitute is 0. It is 1 if the attribute value for the

10   substitute is equal to that for the original.

Product Similarity Index

The Product Similarity Index for Product P_O is calculated as follows:

$$SI_{OQ} = SI_{OQ}(X_{Processor}) \times W_{Processor}\} + \{SI_{OQ}(X_{Memory}) \times W_{Memory}\} + \{SI_{OQ}(X_{HD}) \times W_{HD}\} +$$

15    $$\{SI_{OQ}(X_{CDROM}) \times W_{CDROM}\} + \{SI_{OQ}(X_{Monitor}) \times W_{Monitor}\} + \{SI_{OQ}(X_{OS}) \times W_{OS}\}$$

The above assumes that the weights are normalized to one, i.e. $\sum_i W_i = 1$.

The list of substitute products for each original product is shortened to include only those substitute products for which excess supply is available. The supply information can

be obtained from an available advanced planning engine such as i2 TECHNOLOGIES'

Supply Chain Planner application. The user is presented with the desired number of top-

ranking substitutes in the list.

5   Extension of the Methodology

An important aspect of the present methodology is extensibility. Areas in which the

present invention can be extended include the use of a more extensive analytic process to

arrive at the weights for the selection of alternate products, the presentation of broad

10   product characteristics instead of detailed product attributes to the user, and the

elimination of the need to calculate substitutes for all products in the first stage of the

method described above.

Although the present invention has been described in detail, it should be

understood that various changes, substitutions can be made hereto without departing from

15   the spirit and scope of the invention as defined by the appended claims.

Claims

1.   A system for offering to a user alternate products similar to a requested product, comprising:

5   a first user interface to receive a user request for a product, such product having product attributes;

        a search procedure to select a set of candidate alternate products having attributes similar to the requested product attributes;

        a sort procedure to rank the candidate alternate products in order of decreasing

10   similarity to the requested product; and;

        a second user interface to present the candidate products to the user.

2.   The system of Claim 1, wherein the first and second user interfaces are combined to function as a single interface.

15

3.   The system of Claim 1, further comprising:
        a database connected to the search procedure, the database containing information identifying available products, the availability of such products, and the attributes of such products.

20

4.   The system of Claim 3, wherein the second user interface, when the user selects an alternate product, causes information regarding the availability of the selected alternate product to be updated.

25   5.   A method for offering, to a user, alternate products similar to a requested product, comprising the steps of:

        receiving from the user a request for a preferred product;

selecting a set of alternative products having attributes similar to the preferred product;

rank ordering the alternative products according to their degree of similarity with the preferred product; and

5   presenting to the user the list of alternative products.

6.   The method of Claim 5, wherein the selecting step comprises the steps of:

determining a set of attributes of the desired product;

calculating values representing measures of similarity for attributes of products

10   other than the preferred product;

calculating product similarities for the other products as a function of the attribute similarities; and

selecting as the set of alternative products those other products having a product similarity greater than a selected threshold.
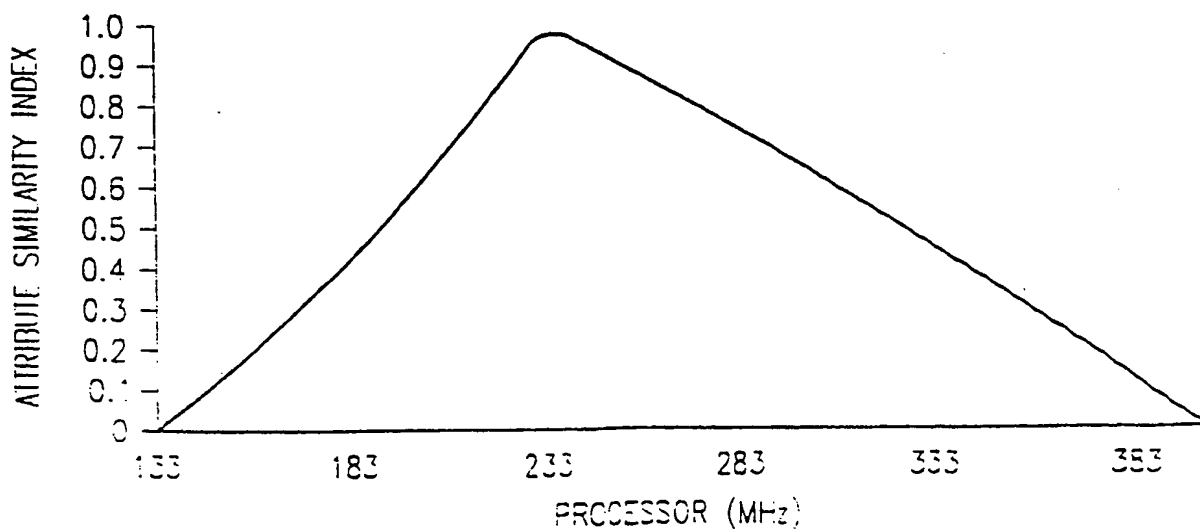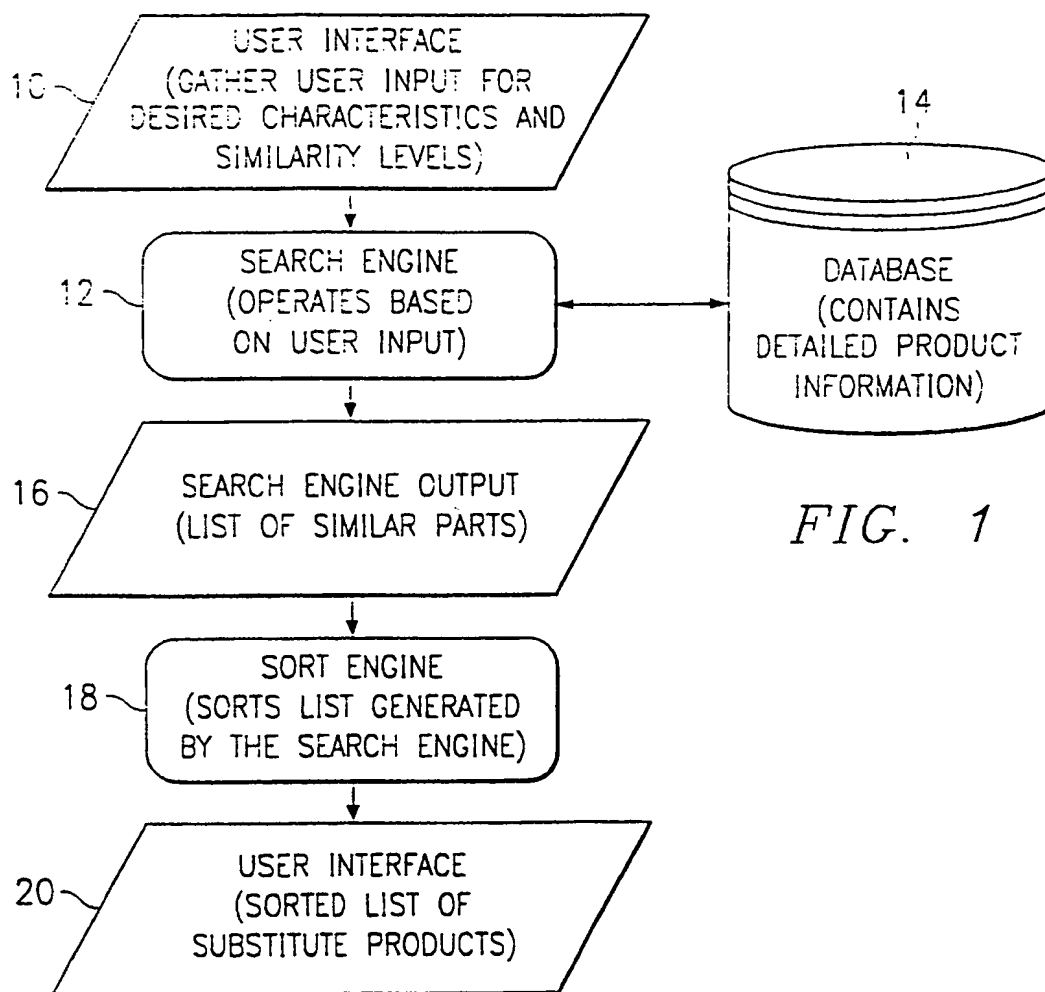
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FIG. 1

FIG. 2

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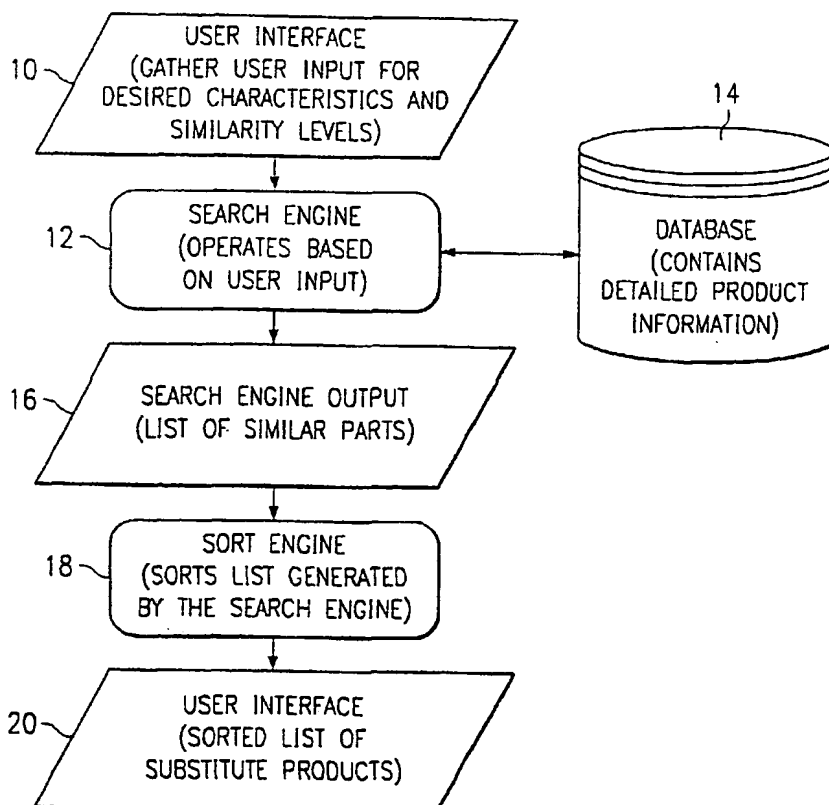
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(54) Title: PRODUCT SUBSTITUTION SEARCH METHOD

(57) **Abstract:** A system and method for responding to user requests for a product provides a selection of alternate products that are similar to the requested product. Available products each have a plurality of attributes, which are compared to corresponding attributes of the requested product. Available products having attributes which are similar to those of the requested product are ranked in order of a similarity measure, and presented to the user.

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INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7   G06F17/60   G06F17/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7   G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, INSPEC, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	WO 97 02537 A (MASSACHUSETTS INST TECHNOLOGY) 23 January 1997 (1997-01-23) page 16, paragraph 4 -page 25, paragraph 2; figure 2	1,2,5,6
Y	page 25, paragraph 6 -page 26, paragraph 5 page 27, paragraph 2 -page 28	3,4
Y	US 4 996 642 A (HEY JOHN B) 26 February 1991 (1991-02-26) column 7, line 22 -column 7, line 46; figure 6	3,4

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[X] Further documents are listed in the continuation of box C.	[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Kruspig, S

Form PCT/ISA/210 (second sheet) (July 1992)

page 1 of 2

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E	US 6 266 649 B1 (JACOBI JENNIFER A ET AL) 24 July 2001 (2001-07-24) column 10, line 4 -column 15, line 67	1-6

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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